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## STRATEGIC PLANNING DOCUMENT

### The Future of Research and Graduate Education for the Department of Microbiology

#### **1. Research and the Faculty**

Microbiology has been and continues to be a critically important area to this campus, the region and beyond. Microbes have enormous impact on the health of the planet and its inhabitants. The stated mission of the Department of Microbiology at UMASS Amherst is “to provide comprehensive quality undergraduate and graduate instruction in the field of microbiology, to conduct world-class research in microbiology, and to provide service to the public sector in the application of microbiology to solve important societal concerns”.

The Microbiology department has a rich and successful history on the UMASS Amherst campus attracting undergraduate and graduate students who have received excellent training in all aspects of microbiology and gone on to productive careers in academia, industry and related areas. The undergraduate program, superbly led by a dedicated and passionate team of educators, has grown considerably in the last 10 years and graduates approximately 60 students per year. Roughly 30% directly enter jobs in industry and research labs and 40% pursue graduate, medical/dental school education. Of the remaining 30%, some take a year or two to decide their direction, many joining post-bac programs in preparation for graduate or medical training. The department enjoys an excellent reputation within the state and beyond for training, and its graduates are sought after by biotech and academic labs looking for well-trained students in this important area.

Microbiology is an unusual enterprise in that the study of microbes involves unique methodologies such as the ability to culture organisms that are difficult to propagate and the necessity to understand microbial metabolic pathways, physiology, and genetic systems that are distinct from typical eukaryotic model systems. For these reasons, it is necessary for microbiologists to continue to exist within a department that provides support for the unique requirements of this field. On the other hand, current approaches in the field of microbiology have embraced many interdisciplinary methodologies leading to productive synergies with fields represented in other units on campus, including Chemical Engineering, Civil and Environmental Engineering, Food Science, Geoscience, Natural Resources, Polymer Science, Veterinary and Animal Sciences, Biology, Biochemistry, Physics and Computer Sciences. Partnerships with the Medical School at UMASS Worcester are expected to play increasingly important roles in the application of microbial research to human health. New methodologies including genomic and bioinformatic analyses, metabolomics, proteomics, an increasing sophistication of biosynthetic ability and systems biology are now recognized as essential for microbial studies. The continued development of synergistic interdisciplinary approaches and interactions between units at UMASS Amherst and UMASS Worcester will be important for the Microbiology department to stay ahead of emerging trends and for other investigators to take advantage of advances made possible by microbial discoveries. With some strategic new hires and investments in infrastructure, the UMASS Microbiology department will be well poised to be a leader in the integration of microbiology with other disciplines and to continue to make a major impact in research and education in these areas.

## 1.1 Our Vision

Microbiology is an essential science, and we are proud to produce an outstanding product that provides support for the unique requirements of this field, the degree of Microbiologist in an independent department dedicated to this large area of biology. This is a particularly exciting time for microbiology, with new discoveries in many areas affecting our lives as well as applications of this information to provide solutions to many problems that afflict our planet including bioremediation, bioenergy, and biogeochemistry.

Our department's program ranks among the top tier of microbiology research and undergraduate and graduate training programs in the nation. Our strength lies in our holistic approach to training microbiologists in the areas of medical microbiology, genetics and physiology, environmental microbiology, and applied molecular biotechnology, where we have attained a critical mass of researchers in each subfield. The continued development of synergistic interdisciplinary approaches and interactions between units at UMASS Amherst and UMASS Worcester will be important for the Microbiology department to stay ahead of emerging trends.

We want to cultivate our current strength to grow beyond our current challenges. We demonstrate strength with productive research programs overall, a varied and enriching intellectual environment, highly visible and very well-funded programs in fundamental and applied environmental microbiology, with sensible plans for recruitment of new faculty, and excellent leadership. Some of our challenges now and in the near future are how to maintain a critical mass of faculty to meet the rich diversity of microbiology topics currently in the department; as well as how to grow into newly emerging areas. Being able to accomplish these two goals is critically important to the education mission of the department; the strength of which is the breadth of research areas. The ability to meet these goals is limited by fiscal constraints and inadequate infrastructure.

## 1.2 Realizing our Vision

### Resources.

**Federal Funding.** The department of Microbiology's funding has remained in the outstanding range for several years. However, what has changed is the distribution of funding. Several years ago the funding was heavily skewed to a few labs. In the last four to five years we have experienced a broader distribution of funding across the labs. In part, this is due to the development of the 5 previously untenured professors. This provides students with more choices of funded labs, reduces the time spent on TA support, and will reduce the time to completion. Collectively, this will result in growth of the Microbiology graduate program and of our Department as an independent entity.

The current federal funding rates are at historically low levels. Considering the challenges faced by UMASS and most other research universities, the reduced funding rates of federal agencies, alternative strategies for funding will be considered. These include SBIR partnerships, partnerships with larger pharmacological or environmental industries, and training grants such as IGERT, GANN, REU, and NRSA. The microbiology department has a history of both industry funding and IP development and plans to intensify this are ongoing by individual initiatives.

**Physical and Administrative Infrastructure.** Currently, Microbiology faculty research labs are housed predominantly in LSL1 and Morrill IVN with two labs located in Fernald. The faculty in LSL1 occupy state of the art research facilities that cluster them with colleagues from other departments with similar research interests. The result of the clustering created a “swiss cheese” effect in Morrill IVN. Optimally, the faculty in Morrill IVN and Fernald could be reorganized to create clusters in Morrill IVN and add on to existing clusters in LSL1. The second floor of Morrill IVN will be renovated this upcoming year as part of a back-fill plan resulting from the LSL1 moves. Additional labs on other floors of Morrill IVN have been renovated recently and can be also be used to cluster Morrill IVN and Fernald occupants. The Micro administrative offices and conference room are also being updated as part of the second floor renovation plan.

While not directly relevant to this part of the strategic planning process, the teaching labs and equipment are woefully inadequate. This is mentioned here because the state of the teaching labs often requires that classes use equipment in research labs. These migrations are not ideal for the students or the ongoing work in the research labs. The lack of suitable teaching equipment has also required that faculty donate equipment purchased with research funds. None of these situations is appropriate for a “destination of choice” and certainly are not the objective of funds from extramural research grants. Poor layout and lack of storage space in teaching labs severely limit the type of experiments that can be done and the number of students that can be served. A total renovation of the teaching laboratories with modernization of equipment needs to be a top priority for the College. Smart design would allow for higher capacity that could easily accommodate Microbiology laboratories along with Geosciences, Food Sciences, and Veterinary and Animal Sciences.

**Recruitment and retention of faculty.** Maintaining a vigorous faculty-hiring program is essential for fostering the scientific community and for continuing to provide excellent educational experiences for undergraduate and graduate students. With some strategic new hires and investments in the infrastructure, the UMASS Microbiology department will be well poised to be a leader in the integration of microbiology with other disciplines and to continue to make a major impact in research and education in these areas.

Growth of faculty size should always be strategic. In choosing specific areas for growth it is advisable to analyze the market share of the Microbiology faculty grants. While funding is the department is excellent it clearly does not reflect the national market distribution of funding for microbiology departments. Funding for microbiology departments nationally is heavily weighted to NIH (84%) and NSF (8%) with the remaining funding from ONR, DOE, USDA and NASA. As stated above, this has largely to do with most Microbiology departments residing in medical schools. Our funding is more heavily weighted towards DOE (5%), ONR (43%), NSF (19%), USDA (20%), and to a lesser extent NIH (13%). Note that our actual funding distribution is much more heavily weighted to DOE than indicated above however, the DOE database is inadequate and does not capture all grants. For example, the above data misses a large 25 million dollar grant won by Prof. Lovley.

Since we represent 1/120 of Microbiology departments, then on average we should have 0.8% of the market share from each funding agency. Thus, we have a greater than average

market share from DOE (>0.7%), ONR (5.5%) and USDA (3.7%) and an appropriate market share of NSF funding (0.7%). However, we clearly have room for improvement in the NIH arena. Our most recent hires of Medical Microbiologists were chosen to help to capture more of this market share.

Expanding our faculty to increase diversity in areas such as medical microbiology will also serve to teach in an expanded curriculum, and provide more opportunities for undergraduate research experience. Specifically, curriculum development in the following areas would be beneficial: an expanded course that covers biochemistry geared to bacterial systems; opportunities to learn about systems biology, metabolic modeling and physiology; an upper level genetics class on genomics and bioinformatics; a course that covers microbiology in the news (current topics such as microbiome, food contamination, biofuels). We may need to entice a senior person with an actively funded program to propel us to faster success in that area. In addition, we cannot overlook our current faculty gender imbalance during subsequent searches for new faculty.

Our department has an outstanding reputation in environmental microbiology. Another goal is to hire two tenure-stream faculty to continue to bolster this reputation. The plan for one of the hires is in an interesting area of research, synthetic biology. This is still a relatively new field, but with a lot of new funding opportunities emerging that include federal (DARPA and ONR both had new programs come out last year; NSF also participated in a call in this area) as well as industry. Therefore, synthetic biology should be a very good future focus for UMass to create research that has the possibility to attract funding from several federal funding agencies as well as industry. The potential for spin-off companies that would benefit the local economy is high. To do this effectively, would require more than one hire. This will be coordinated with other departments like chemical engineering. The second hire will focus on individuals that can strengthen the interaction between microbiology and geosciences such as a biogeochemical systems modeler. Two of our faculty (Holden and Nusslein) have extensive interactions with the geosciences department which is in close physical proximity.

An essential part of a successful and strong long term academic planning is a well-formalized mentorship program for junior and midlevel faculty members. This ensures not only retention but also the productivity needed to justify rising start up packages.

**Support and Productivity of Tenured Faculty.** An important issue to strengthen both our department as well as stabilize productivity of tenured faculty will be to foster inter- and intradepartmental relationships. We will maintain and strengthen connections within the department and continue and intensify to build bridges to other microbiologists on campus and at the Medical School to build the awareness of the importance of microbiology to the campus, region, and the state. The microbiology department will continue to embrace its diversity.

In the overall poor current funding climate, it is essential for our faculty members to have a clear bridge-fund mechanism available to assist during a year between research grant funding. CNS has entered into a discussion about such a mechanism although this has yet to be implemented. However, the Department has initiated a bridge funding mechanism. The funds are drawn from the departmental RTF. The amount awarded is calculated based on funding rate of the individual PI and the funds have to be repaid to the RTF once the PI has re-established extramural funding.

**Faculty Retirement.** Our strategic plan for faculty retirement projection is focused not only on replacement of retired faculty members with tenure track faculty, but especially on growth beyond the current demographics. An increase in the number of tenure track faculty will directly enable us to expand into more funding opportunities, to match the dramatic rise in undergraduate student majors, to expand our graduate student cohort, as well as increase our ability to apply for larger research proposals.

## **2. Graduate Education**

The Microbiology department offers a PhD and several MSc degree programs. The MSc programs include a traditional research-based degree, a fifth-year program, and a recently launched one-year Applied Molecular Biotechnology (AMB) degree. General descriptions of these programs are provided later in this document.

The microbiology department takes pride in maintaining very high standards for hiring faculty and accepting graduate student applicants. First, our department consists of top-caliber researchers who are working and publishing in cutting-edge areas of microbial research. Second, our graduate students are trained in a wide range of fundamental microbial, proteomics, cell biology, genetics and immunology techniques. These techniques are utilized along with cutting edge technologies in the field of microbiology that better prepares them for a diverse and ever-changing work force. As the microbiologist Louis Pasteur once said, “Chance favors the prepared mind.” Third, our department is very collegial and collectively works to help all of our graduate students succeed at all levels of training. Graduate students are attracted to the accessibility of faculty and the family atmosphere that exists in our department. From the regular TGIF social gatherings organized by the graduate students to holiday dinners and retreats, the department seeks opportunities to maintain a cohesive and collaborative atmosphere within which to work and study.

### **2.1.1 Doctoral Program – Our Vision**

As mentioned above, of the ~120 microbiology graduate programs in the US, most are at medical schools. These programs are built on a basis of NIH funding and substantially lower teaching responsibilities. The Microbiology PhD. Program at UMass is unusual from two perspectives. First, it is on an undergraduate campus. Second, the research focus is more diverse than what is typically found in any medical school program. This makes UMass unique and provides for more diverse training of the graduate student population and creates an unusually diversified funding portfolio. Every year, the department hosts domestic prospective students (typically fourteen PhD applicants) at a retreat in March. In addition, international applicants are interviewed by faculty via Skype. All of these students are asked why they chose to apply to the program at UMass. The overwhelming majority of students indicate that it is the diversity of research programs that attracted them to UMass. They do not apply to medical school-based programs and often lament the scarcity of non-medical Microbiology Programs in the US. However, it also creates a challenge in maintaining a critical mass in all of the research areas. Because of this, planned faculty hires are focused on maintaining the research diversity and critical mass.

The Microbiology Graduate Program was classified as *aspirant* in the recently completed graduate program review process. It was deemed to be “*an excellent program with superb grant performance.*” This evaluation is even more impressive given that the Academic Analytics (AA) database missed several grants from DOE and also because of a problem with the faculty count. It is even more remarkable given that five of the faculty, were pre-tenure in the period covered by the AA review.

The fact that the above-mentioned graduate programs are departmentally-based has been the subject of substantial discussion on the UMass campus given that many of our faculty are also members of the MCB (Burand, DeAngelis, Griffith, Klingbeil, Lopes, Morita, Sandler, and Siegrist) and OEB (DeAngelis, Nüsslein, and Rich) interdisciplinary programs. Some of our faculty are not members of any interdisciplinary programs (Holden, Lovley, and Webley). Notably, we do not observe any overlap of applications to the Microbiology graduate programs with these interdisciplinary graduate programs. Thus, it is evident that our program serves a niche of students in the marketplace and draws students to UMass that otherwise might not apply here. A fundamental question is can departmentally-based programs and interdisciplinary programs co-exist and are there benefits/costs to a mixed model?

The interdisciplinary programs are very popular and attract a strong cohort of students that are interested in the size and diversity of these types of programs. They are also an ideal mechanism for interdepartmental interactions. For these reasons and many others, the interdisciplinary programs are worth the investment by UMass. However, there is no denying that these programs require considerable funds to run the cognate administrative offices, seminar series, recruiting activities, and leadership supplements. The departmental programs are more focused and attract a different cohort of students. Our departmental program does not cost UMass in any appreciable way. The cost of recruiting and seminars are covered from a variety of sources including gift funds and faculty-generated RTF. The administrative functions associated with our graduate programs are a small part of the role fulfilled by Microbiology staff with broader responsibilities.

In spite of the aforementioned issues the question still remains; would there be a benefit to having an interdisciplinary program in Microbiology at UMass? To a great extent Microbiology already is an interdisciplinary program. This is evident in the fact that graduate students are free to join research labs in our department as well as other departments whose faculty hold adjunct appointments in Microbiology. For example, students in the program are currently under the direction of faculty in the departments of Food Science as well as Biochemistry and Molecular Biology. Over the last decade this list also includes the departments of Biology, Veterinary and Animal Sciences, and Plant Soil and Insect Sciences. Students can also choose to study with faculty from Geosciences. The process for securing an adjunct appointment in Microbiology is indistinguishable from securing membership in the current interdisciplinary programs. Thus, it would be fairly trivial to change the Microbiology program to an interdisciplinary program. However, it is not immediately obvious if this would constitute a meaningful or impactful change. Notably, one necessary change to bring it in line with the current interdisciplinary programs is that it would require independent funding support.

Another important consideration is whether there are the costs/benefits associated with having Microbiology faculty associated with other interdisciplinary programs. Individual Microbiology faculty participate in the interdisciplinary programs to differing degrees.

However, it is obvious that the MCB and OEB programs benefit greatly from Microbiology participation. One example of this is that two Microbiology faculty (John Lopes and Kevin Griffith) teach courses designed for the MCB program. Our faculty participate on virtually every committee of the MCB program including, steering, graduate admissions, and seminar organization. Our faculty regularly attend the graduate student colloquium series and the seminar series. The only appreciable cost to the interdisciplinary programs would be the assignment of graduate students in Microbiology faculty labs. Over the last eight years only one MCB student and one OEB student have been placed in Microbiology labs. Thus, the benefit of Microbiology faculty membership to the interdisciplinary programs far outweighs any cost. Moreover, any small costs have been mitigated by the fact that the Microbiology program has provided financial support in the form of a TA to the MCB student in a Microbiology lab even though it is not obligated to do so and has also on occasion provided TA support for students in the MCB program not being trained in Microbiology labs.

### **2.1.2 Doctoral Program – Realizing our Vision**

It cannot be stressed sufficiently that the Microbiology PhD, MS graduate program is tightly coordinated with the number of professors in the Department and their funding at any one given time. Our competitive advantage is also our Achilles heel: our diversity in the myriad research areas, being able to offer many courses in this rich and evolving field such that our energies are divided between teaching and research when it comes to applying for grants. This diversity and our course offerings make us more attractive to students who love microbes at all levels. What limits the number of students in our program, like most departments/programs, is predominantly the number of grants. Thus, all students who come to our program are guaranteed funding. While other programs, may offer a higher stipend, we lose a few students for this reason (although data for this is difficult to collect). We have high student satisfaction as few students who come choose to transfer to another program. We know that students who pick us, do so because of what we have to offer in research and courses. We feel that to become more competitive for the better students, we will have to increase the number of faculty and the number of grants per faculty. We also need to increase the amount of our stipend to make us more competitive with similar programs.

We are good at recruiting students. We usually have over 100 applicants per year and are able to accept a reasonable number to fulfill the needs of the Department in teaching and research. We have worked effectively with the STEM diversity institute to successfully recruit under-represented minorities in the past and will continue to do this in the future. Once trained, our graduates have found employment in industry academia, law, and public policy.

The Microbiology Department has identified several program priorities that are designed to bring the program into the top tier in the next five years. One goal includes growth in faculty size. The graduate review process carried out by the Graduate School clearly revealed the graduate programs in CNS have fewer faculty than peer institutions. The data comparing UMass programs to aspirant universities show that there is a correlation between grant size and size of the faculty. Thus, increasing faculty size should be a priority for the university especially with respect to aspirant programs. New faculty hires should be chosen to complement and concentrate strengths in areas of research. With more faculty, we will be able to decrease our standard teaching load (possibly increasing the number of courses, particularly 500 level open to both graduate students and undergraduates in our areas of specialties) and this would allow us to

spend more of our effort on research, writing papers, mentoring graduate students and obtaining extramural funding.

We also noted that the time to degree is increasing with a number of students in the 6-8 year completion range. This is partly due to the large number of pre-tenure professors in the department, although, there may be other contributing factors. The Graduate Committee in the Microbiology Department analyzed completion rates more closely and found that it mostly correlated with specific professors and not with specific research areas. This information has been used to mentor the relevant faculty as well as new professors joining the Department. The Department has also initiated a rotation program, which is a consistent practice among all of the aspirant university programs.

**What will the program need help to do?** The main area where the Microbiology Graduate Program will need assistance is in increasing faculty size. Increasing faculty size is of course a major challenge in a fiscally constrained environment. The Microbiology Department has been limited to replacement hiring over the last decade and lost some positions to budget cuts. Thus, our ability to grow has been dampened. Certainly, in a perfect situation the university would want to evenly distribute hiring across the college. The current fiscal situation is far from perfect. Consequently, the university must make difficult decisions in terms of where to allocate resources. It would seem logical that the university would want to invest faculty positions and growth into *aspirant* programs since these are going to have the greatest impact in improving the research image of the campus. We would require the cooperation of the university in increasing faculty size. Faculty hiring will be strategic by choosing specific areas for growth dictated by the market share of the Microbiology faculty grants.

**What can the Microbiology program do on its own?** As noted above the major challenge we can address is the time to degree completion. It is not important to do this for the purpose of comparing more favorably with aspirant programs but because of practical considerations. Most federal grants average three to four years. Thus, two to three consecutive grants may be required to fund a student over a six-year period. As noted above, we are mentoring faculty on the importance of time to degree and we have also initiated a rotation program for incoming students. Students are required to rotate in two labs (three if necessary) before choosing a lab for their research program. It may seem counterintuitive that a rotation program would shorten time to degree completion. However, rotations identify better student - professor matches, which results in increased productivity and also stimulates competition for graduate students. Clearly having a reputation for prolonged time to degree would provide a disadvantage in such a competition. Within the rotation program, there is mentoring from a committee of three professors (includes the GPD).

### **2.2.1 Master's Programs – Our Vision**

M.Sc. programs in the biological sciences are traditionally a minimum of two years. As mentioned earlier, Microbiology offers three types of M.Sc. degrees, a traditional research-based degree, a fifth-year program, and a recently launched one-year Applied Molecular Biotechnology (AMB) degree. The table below provides a comparison of the requirements for the three programs.



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	<u>Fifth Year</u>	<u>Traditional</u>	<u>Appl. Mol. Biotech.</u>
Degree Completion (months)	15	~24	12
Thesis requirement	NO	YES	NO
Internship	NO	NO	YES
Research Experience	faculty sponsored	faculty sponsored	Applied and Individual Project
Student Demographics	UMASS only	Domestic & International	Domestic & International
Coursework credits	21	12	13
Research credits	9	18	17
<b>Total Credits</b>	<b>30</b>	<b>30</b>	<b>30</b>

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We implemented the Fifth Year Masters program in 2002 to address an increasing need among our undergraduate students to acquire skills that would make them more competitive in the emerging biotechnology and pharmaceutical markets. Since that time, we have had success in recruiting top quality students from within the UMass student body for our Fifth Year Master's program in Microbiology ranging from 3-8 UMass students joining our program each year.

Given the economic situation of the last 5 years, we believe that students are less likely to enroll in a two year program due to the prohibitive cost and time commitment required to complete these degrees. We believe that a future trend in higher education will likely involve shortening M.Sc. programs to a single year. Therefore, we also recently initiated a one-year, non-thesis professional Master's degree in Applied Molecular Biotechnology (AMB) that has successfully placed its graduates in various biotechnology and pharmaceutical industries. The AMB program combines state-of-the-art laboratory training with lecture-based courses to train students in the latest techniques and concepts of molecular biology and biochemistry. Students are specifically trained over the course of the year in protocols most desired by the leading biotech companies, making them highly competitive in the job market. The curriculum was designed with the biotechnology industry in mind to provide students with a broad knowledge base and the research skills to be competitive for positions in industry, but also academia.

This is a highly attractive program for anyone with a BS degree in the sciences looking to do graduate work towards the MS degree with a guaranteed short turnaround. These graduates command starting salaries that are in the range of \$15K to \$20K more than they would receive with the BS degree, making this an excellent investment. Microbiology enjoyed a successful first year for this program in which all students were placed in Biotech Internships. This aspect of the program was implemented 1 year ahead of schedule.

We currently award more M.Sc. than Ph.D degrees with an average of 8 M.Sc. per year with the exception of 2013-2014 in which we awarded 21 M.Sc. degrees; the year that the AMB program was implemented. All of the M.Sc. programs are designed to be revenue-generating

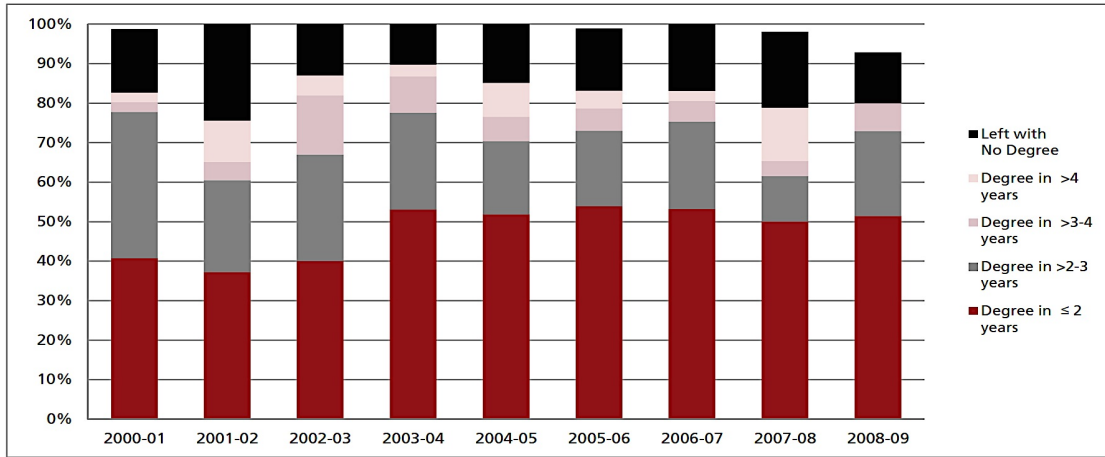
programs and we feel that we can continue to grow these programs to capitalize on these resources. The Microbiology M.Sc. programs are among the top performing programs in the College of Natural Sciences in terms of graduating students in 2 or less years (see bar graphs below).

### **2.2.2 Master's Programs – Realizing our Vision**

Expansion of the AMB program will be essential as part of our plan for increased revenue. We currently expect to admit 10-14 students into the AMB program each year. No additional resources are needed for the coursework part of the AMB concentration as pre-existing courses in the Microbiology and Biochemistry Departments will be utilized. Many of the courses are already being taught by professors in the Microbiology Department, and there exists sufficient space in the classrooms to accommodate these additional students. Experiences from last year and this second year of the program indicate that we could expand to 18 students.

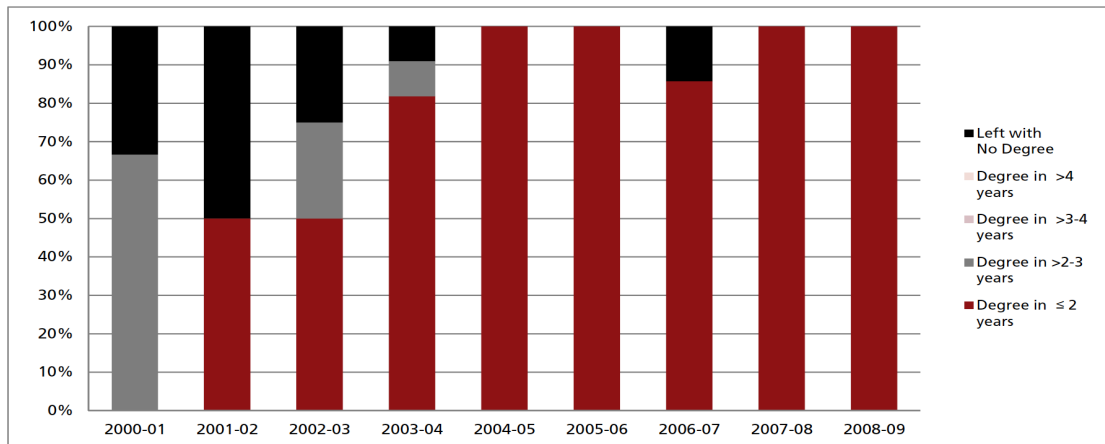
However, further expansion will require hiring another dedicated lecturer to assist in the intensive hands-on training in basic molecular biology concepts and techniques. The 2<sup>nd</sup> lecturer will also be essential to guide the individualized projects that each student completes as part of the AMB program. The projects based component of the AMB program is one of the unique features of our program. Additionally, the current lab space that is used for AMB is shared with another course. To fully expand, new space or renovated space will need to be identified to accommodate further expansion of this revenue generating program. Lastly, as the numbers of students continue to increase, accommodations will also be necessary as current class limits will likely be exceeded. A major source of concern is that this program was launched with the understanding that revenues would be returned to the Department of Microbiology. Both CNS and the Department contributed significant funds to purchase equipment and supplies and hire the instructor. The understanding was that the revenue would be used to pay back the set up costs to CNS and the Department. The revenue return has been minimal and insufficient to pay the salary of the instructor and purchase supplies and completely inadequate to repay CNS and the Department.

### College of Natural Sciences: Masters Completion and Time to Degrees by Cohort



The difference between the top of each column and 100% represents the students who are still active.

### Microbiology Department: Masters Completion and Time to Degrees by Cohort



The difference between the top of each column and 100% represents the students who are still active.

## Summary

The microbiology program at UMass Amherst ranks in the top tier of microbiology research as well as undergraduate and graduate training programs in the nation. Therefore we are a destination of choice and a point of pride for UMass. The department seeks to develop and maintain exceptional scholarly research programs while training and educating the next generation of microbiology professionals. Our goals are:

1. To attain a critical mass of faculty to grow the rich diversity of microbiology topics currently represented in the department.
2. To grow into newly emerging areas of research.
3. To grow to meet the needs of graduate student applicants searching for a Microbiology Program with diverse research areas.
4. To continue to support existing interdisciplinary graduate programs.
5. To grow the revenue-generating MSc programs.

Growing our faculty in specific areas of emerging research interest will not only ensure continued extramural funding support, but will also help to solve some of our current challenges of faculty teaching load, time to completion of graduate degrees and increasing the number and diversity of graduate courses offered. With the confluence of new findings, innovative approaches and experimental tools, the increasing biological and clinical significance of research findings in the field, this is an exciting time for microbiology research! Even with the varied challenges, career opportunities are plentiful in academic, government services, research, industry and a myriad of other avenues. It is undeniable that microbiology is fundamentally important to advances in public health, policy, and education in the 21<sup>st</sup> century and the microbiologists here at UMass Amherst are poised to play a significant role in these advances.